



TEST REPORT 82/600/NP: 2010 Ammonia corrosion testing of photovoltaic (PV) modules	
Report Reference No.....	68.290.11.010.01
Compiled by (+ signature)	Laura Wang 
Approved by (+ signature)	Harry Zhang 
Date of issue.....	2011-07-25
Testing Laboratory	Jiangsu TÜV Product Service Ltd. - Shenzhen Branch
Address.....	6/F, H Hall, Century Craftwork Culture Square, No. 4001, Fuqiang Road, Futian District, Shenzhen 518048 P.R. China
Applicant's name	BYD CO LTD.
Address.....	Baolong Industrial Town, 1 Bao Ping Rd. , 518116 Longgang, Shenzhen, Guangdong, PEOPLE'S REPUBLIC OF CHINA
Test specification:	
Standard	82/600/NP
Test procedure	Test report
Non-standard test method.....	N/A
Test Report Form No.	TÜV_82/600/NP
Test Report Form Originator.....	TÜV SÜD Product Service
Master TRF.....	Dated 2011-07
Test item description	Poly-crystalline Silicon Photovoltaic (PV) Module(s)
Trade Mark	BYD
Manufacturer.....	Shanghai BYD Company Limited No. 999, Xiangjing Road, Songjiang 201611 Shanghai, PEOPLE'S REPUBLIC OF CHINA
Model/Type reference.....	BYD235P6-30
Ratings.....	V_{oc} : 37.07 V; I_{sc} : 8.69 A; P_{max} : 235 W

Summary of testing:

Tests performed (name of test and test clause):

Clause 6.1, Initial measurements:

- MST 01: Visual inspection
- 10.2: Maximum power determination
- MST 16: Dielectric withstand test
- 10.15: Wet leakage current test
- MST 13: Ground continuity test

Clause 9.1, Final measurements:

- MST 01: Visual inspection
- 10.2: Maximum power determination
- MST 16: Dielectric withstand test
- 10.15: Wet leakage current test
- MST 12: Ground continuity test
- Bypass diode functionality test

Clause 7: Ammonia resistance test

Testing location:

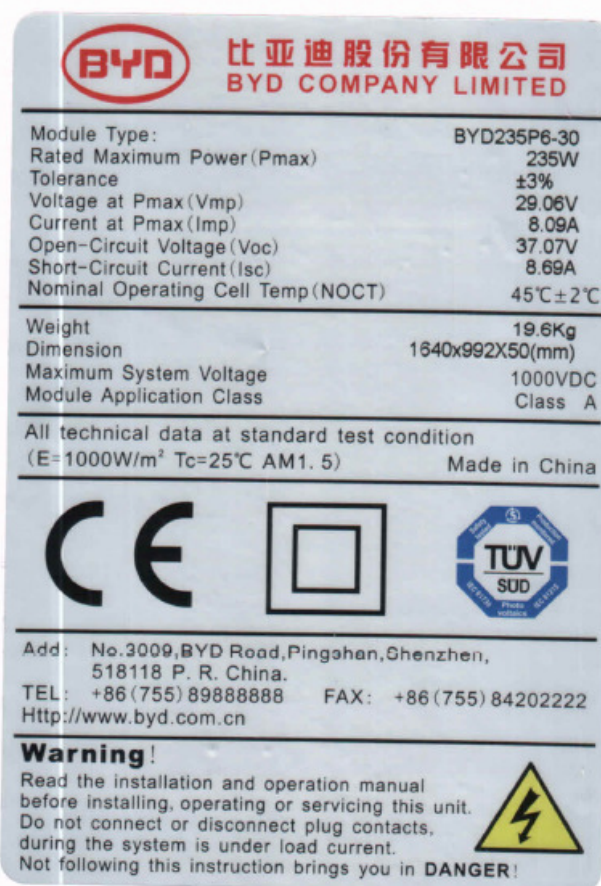
PI Photovoltaik-Institut Berlin AG
Wrangelstraße 100
D-10997, Berlin, Germany
(Performed initial and final measurements)

TechnoLab
Am Borsigturm 46
D-13507 Berlin, Germany
(Performed Ammonia resistance test)

Summary of compliance with National Differences:

N/A

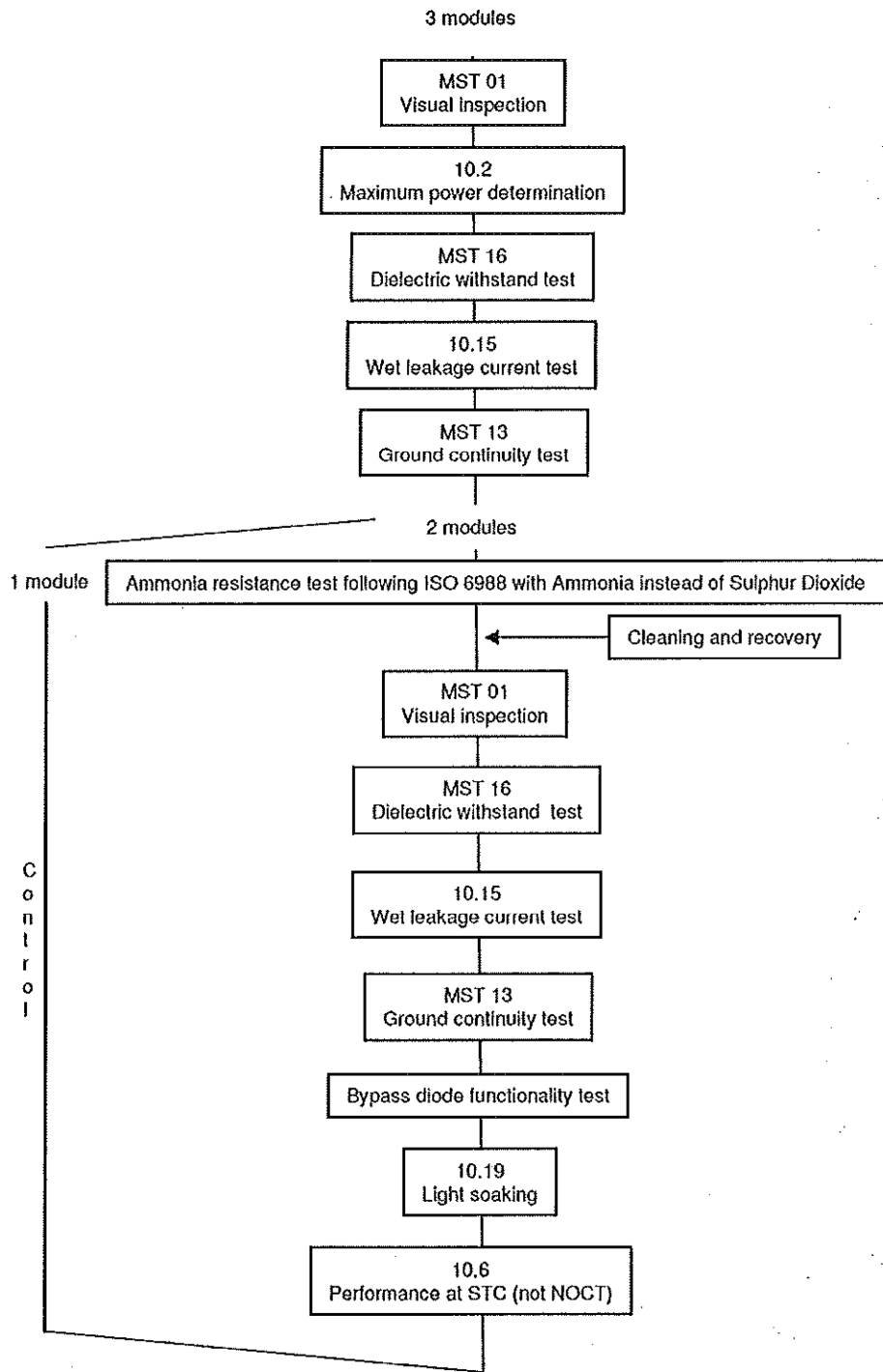
Copy of marking plate:





Test item particulars	
Accessories and detachable parts included in the evaluation.....	N/A
Option included.....	N/A
Possible test case verdicts:	
- test case does not apply to the test object	N/A
- test object does meet the requirement	P (Pass)
- test object does not meet the requirement	F (Fail)
Testing	
Date of receipt of test item.....	2011-04-16
Date (s) of performance of tests.....	2011-04-16– 2011-07-11
Abbreviations used in the report:	
STC – Standard Test Conditions	WL -- Wet leakage current
I _{mp} – Maximum power current	V _{mp} – Maximum power voltage
I _{sc} - Short circuit current	V _{oc} – Open circuit voltage
P _{mp} – Maximum power	
General remarks:	
<p>The test results presented in this report relate only to the object tested. This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory. "(see Enclosure #)" refers to additional information appended to the report. "(see appended table)" refers to a table appended to the report.</p> <p>Throughout this report a point is used as the decimal separator. Summary of contents provided on the last page of this report.</p>	
General product information and considerations:	
Product Electrical Ratings:	
Type or model number	BYD235P6-30
V _{oc} (Vdc)	37.07
V _{mp} (Vdc)	29.06
I _{mp} (Adc)	8.09
I _{sc} (Adc)	8.69
P _{max} (W)	235
Maximum system voltage:	1000Vdc
Serial number (Sample #)	1. SH110324P630B-T-0086 2. SH110324P630B-T-0083 3. SH110324P630B-T-0091
Polarity of terminals or leads	"+" and "-" polarity is marked on the connectors

Figure 1 Ammonia resistance test sequence for crystalline PV modules (if it is not a full test, strikethrough non-performed test)





82/600/NP: 2010			
Clause	Requirement + Test	Result--Remark	Verdict
3	Samples		P
	— Three identical samples of the model of PV module or assembly of interest must be subjected to any of the testing sequences included in Figures 1, 2, or 3.		P
	— Full-size sample or representative sample	Full-size sample	P
	— PV module provided with means for grounding then they constitute a part of the test sample.		P
4	Test procedures		P
	— All tests included in Figures 1, 2 or 3, except the bypass diode functionality test, are fully described in the IEC standards	Figure 1 applied	P
4.1	Bypass Diode Functionality Test		P
4.1.3	This procedure can be conducted in any ambient within 25±10°C		P
	a) Electrically short any blocking diodes incorporated to the test sample.	No blocking diode	N/A
	b) determine the rated STC short-circuit current	8.69 A	P
	c) The current shall pass through the cells in the reverse direction and through the diodes in the forward direction.		P
	d) Apply a current equal to of 1.25 times the STC short-circuit current of the test sample for a period of 1 hour.	10.86 A	P
4.1.4	After the 1 hour of current flow check that the bypass diodes remain operational.		P
5	Preconditioning		P
	— All test samples must be preconditioned with either global or direct normal sunlight according to the specifications given in the applicable Design Qualification and Type Approval IEC standard applicable.		P
6	Initial Measurements		P
6.1	Crystalline silicon	See appended table	
	— Tests according to IEC 61215 a) 10.2: Maximum power determination b) 10.15: Wet leakage current test	See appended table	P

82/600/NP: 2010			
Clause	Requirement + Test	Result--Remark	Verdict
	– Tests according to IEC 61730-2 c) MST 01: Visual inspection d) MST 12: Ground continuity test e) MST 16: Dielectric withstand test	See appended table	P
6.2	Thin-film technologies		N/A
	– Tests according to IEC 61646 a) 10.2: Maximum power determination b) 10.15: Wet leakage current test		N/A
	– Tests according to IEC 61730-2 c) MST 01: Visual inspection d) MST 12: Ground continuity test e) MST 16: Dielectric withstand test		N/A
7	Ammonia resistance test procedure		P
7.1	Testing facility and material		P
	As described in section 3 of ISO 6988		P
7.2	Test condition and execution	See appended table	P
	– specimen position: the inclination to the vertical of the face of the module normally exposed to solar irradiance shall be 15° to 30° inside the climatic chambers.	30°	P
8	Cleaning and recovery		P
	– After the ammonia test all samples must be washed to remove the adherent ammonia using running tap water for a maximum time of 5 minutes per square meter of area of the sample.		P
9	Final Measurements		P
9.1	Crystalline silicon	See appended table	P
	– Tests according to IEC 61215 a) 10.2: Maximum power determination b) 10.15: Wet leakage current test	See appended table	P
	– Tests according to IEC 61730-2 c) MST 01: Visual inspection d) MST 13: Ground continuity test e) MST 16: Dielectric withstand test	See appended table	P
9.2	Thin-film technologies		N/A

82/600/NP: 2010			
Clause	Requirement + Test	Result--Remark	Verdict
	– Tests according to IEC 61646 a) 10.2: Maximum power determination b) 10.15: Wet leakage current test		N/A
	– Tests according to IEC 61730-2 c) MST 01: Visual inspection d) MST 13: Ground continuity test e) MST 16: Dielectric withstand test		N/A

10	Requirements		P
10.1	Crystalline silicon		P
	– After the ammonia exposure test, no evidence of major visual defects as described in IEC 61730-2;		P
	– After the ammonia exposure test the maximum power shall not decrease by more than 5% of the initial value;	See appended table	P
	– All pass fail criteria corresponding to tests 10.15, MST 13 and MST 16 must be fulfilled;	See appended table	P
	– The requirement for the bypass diode functionality test must be also fulfilled.		P
10.2	Thin-film technologies		N/A
	– After the ammonia exposure test, no evidence of major visual defects as described in IEC 61730-2;		N/A
	– After the light soaking the maximum power at STC shall not be less than 90% of the minimum value specified by the manufacturer in the marking of the PV module;		N/A
	– All pass fail criteria corresponding to tests 10.15,10.19, MST 13 and MST 16 must be fulfilled;		N/A
	– The requirement for the bypass diode functionality test must be also fulfilled.		N/A



6-c)	TABLE: Visual inspection (Initial)		P
Test Date [MM/DD/YYYY].....:		2011-04-16	—
Sample No.	Nature and position of initial findings – comments or attach photos		Verdict
1	No major visual defects		P
2	No major visual defects		P
3	No major visual defects		P
Supplementary information: N/A			

6-a)	TABLE: I-V characteristic at STC (Initial)						P
Test Date [MM/DD/YYYY].....:		2011-04-16				—	
Radiant Source.....:		<input checked="" type="checkbox"/> Solar simulator		<input type="checkbox"/> Natural Sunlight			
Module temperature [°C]..... :		Corrected to 25				—	
Irradiance [W/m ²]..... :		Corrected to 1000				—	
Sample No.	Voc [V]	Vmp [V]	Isc [A]	Imp [A]	Pmp [W]	FF [%]	
1	37.50	29.42	8.527	8.052	236.9	74.08	
2	37.52	29.26	8.598	8.059	235.8	73.11	
3	37.69	29.50	8.586	8.083	238.5	73.68	
Supplementary information:							
Type of solar simulator: Class A type Pasan SS3b							
Temperature coefficients:							
$\alpha = 0.045\%/K$							
$\beta = -0.34\%/K$							
$\delta = -0.47\%/K$							

6-e)	TABLE: Insulation test (Initial)					P
Test Date [YYYY-MM-DD]..... :		2011-04-16			—	
Test Voltage applied [V]..... :		1000/6000			—	
Sample #	Measured	Required	Dielectric breakdown		Result	
	MΩ	MΩ	Yes (description)	No		
1	10000	24.7	--	No	P	
2	10000	24.7	--	No	P	
3	10000	24.7	--	No	P	
Supplementary information: Size of module [m ²]: 1.62m ²						



6-b) TABLE: Wet leakage current test (Initial)		P	
Test Date [MM/DD/YYYY].....:	2011-04-16	—	
Test voltage applied [V]	1000 Vdc	—	
Module maximum system voltage rating (V, DC)..... :	1000	—	
Solution resistivity [Ω cm], < 3,500 Ω cm at 22 \pm 3 $^{\circ}$ C.....:	Yes	—	
Sample No.	Measured [$M\Omega$]	Limit [$M\Omega$]	Result
1	179.7	24.7	P
2	137.3	24.7	P
3	169.0	24.7	P
Supplementary information: Size of module [m^2]: 1.62 m^2			

6-d) MST 13 – ground continuity test (Initial)		P		
Maximum over-current protection rating (A)	15A	—		
Current applied (A)	15*2.5=37.5A	—		
Location of designated grounding point.....:	On the middle of the longest frame	—		
Location of second contacting point.....:	Adjacent frame	—		
Sample No.	Position in test sequence:	Volatge (V)	Resistance (Ω)	
1	Initial examination	0.235	0.006	P
2	Initial examination	0.255	0.007	P
3	Initial examination	0.195	0.005	P
Supplementary information: N/A				

7 TABLE: Ammonia resistance test procedure		P		
Cycles	1 test section	Hours	8 including heating up	—
		NH3 - Concentration	6667 ppm	—
		Temperature	40 $^{\circ}$ C \pm 3 $^{\circ}$ C	—
		Rel. Humidity	100%, saturation	—
	2 test section	Hours	16 including cooling	—
		NH3 - Concentration	0 ppm	—
		Temperature	18 to 28 $^{\circ}$ C	—
		Rel. Humidity	75% max.	—
Duration.....:		20 cycles (480 hours)	—	
Supplementary information: N/A				



9-c		TABLE: Visual inspection (Final)	P
Test Date [MM/DD/YYYY].....:		2011-06-27	—
Sample No.	Nature and position of initial findings – comments or attach photos		Verdict
2	Frame sealing delamination, ammonia corrosion on the whole frame surface		P
3	Frame sealing delamination, ammonia corrosion on the whole frame surface		P
Supplementary information: N/A			

9-a		TABLE: Maximum power determination (final)							P
Test Date [MM/DD/YYYY] start-end		2011-06-27							—
Module temperature [°C] low-high		corrected to 25							—
Irradiance [W/m ²] low-high.....		corrected to 1000							—
Sample #	V _{oc} [V]	V _{mp} [V]	I _{sc} [A]	I _{mp} [A]	FF [%]	P _{mp} [W]	Degradation [%]	Limit [%]	
2	37.24	29.48	8.531	7.926	73.55	233.7	-0.9	-5	
3	37.38	29.63	8.508	7.939	73.96	235.2	-1.4	-5	
Supplementary information: Type of solar simulator: Class A type Pasaan SS3b Temperature coefficients: $\alpha = 0.045\%/K$ $\beta = -0.34\%/K$ $\delta = -0.47\%/K$									

9-e		TABLE: Insulation test (Final)				P
Test Date [YYYY-MM-DD]		2011-07-06				—
Test Voltage applied [V]		1000/6000				—
Sample #	Measured	Required	Dielectric breakdown		Result	
	MΩ	MΩ	Yes (description)	No		
2	4800	24.7	--	No	P	
3	2500	24.7	--	No	P	
Supplementary information: Size of module [m ²]: 1.62m ²						

9-b		TABLE: Wet leakage current test (Final)			P
Test Date [MM/DD/YYYY].....:		2011-07-06			—
Test voltage applied [V]		1000 Vdc			—
Module maximum system voltage rating (V, DC).....:		1000			—
Solution resistivity [Ω cm], < 3,500 Ω cm at 22 ± 3 °C.....:		Yes			—
Sample No.	Measured [MΩ]		Limit [MΩ]	Verdict	

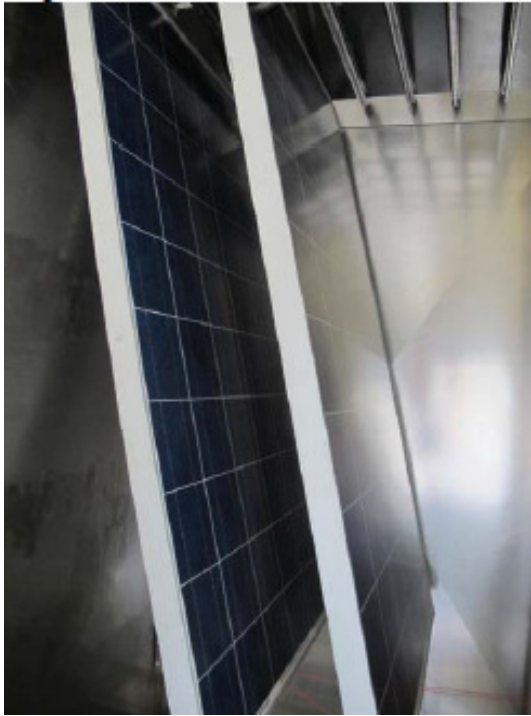


2	98	24.7	P
3	98	24.7	P
Supplementary information: Size of module [m ²]: 1.62m ²			

9-d)	MST 13 – ground continuity test			P	
	Maximum over-current protection rating (A)	15A	—		
	Current applied (A)	15*2.5=37.5A	—		
	Location of designated grounding point	On the middle of the longest frame	—		
	Location of second contacting point	Adjacent frame	—		
	Sample No.	Position in test sequence:	Volatge (V)	Resistance (Ω)	
	2	Ammonia corrosion	Preconditioning		—
		Final examination	0.265	0.007	P
	3	Ammonia corrosion	Preconditioning		—
		Final examination	0.195	0.004	P
Supplementary information: N/A					

9-f)	TABLE: Bypass diode functionality test						P	
	Test Date [MM/DD/YYYY] start-end	2011-07-08					—	
	Number of diodes in junction box	6					—	
	Diode manufacturer	HY Electronic					—	
	Diode type designation	10SQ050					—	
	Max. permissible junction temperature T _{Jmax} [°C] (according to diode datasheet)	200					—	
	Sample No.	D1	D2	D3	D4	D5	D6	—
	2	P	P	P	P	P	P	—
	3	P	P	P	P	P	P	—
Supplementary information: N/A								

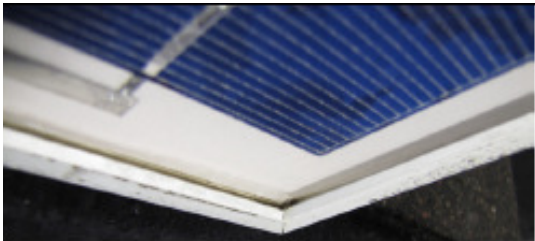
Photos of samples



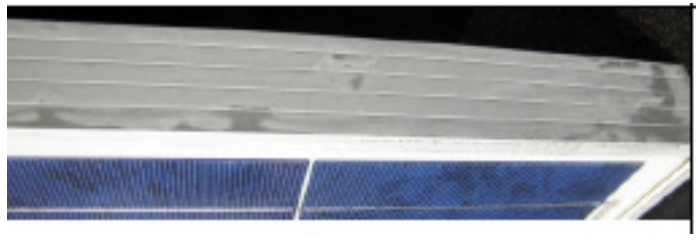
Before ammonia test



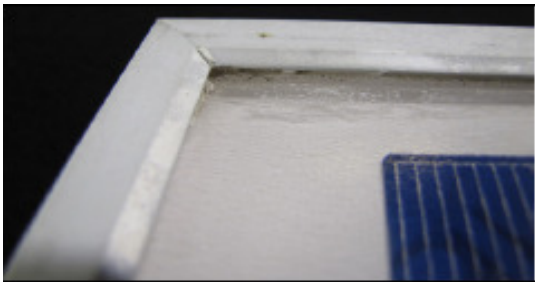
After ammonia test



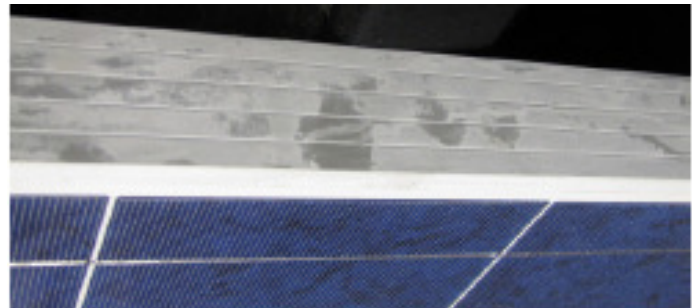
Frame sealing delamination
for sample2



ammonia corrosion on the whole frame surface
for sample2



Frame sealing delamination
for sample3



ammonia corrosion on the whole frame surface
for sample3

END OF REPORT